Renewable and Sustainable Energy Reviews 14 (2010) 1088–1095

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Assessment of public acceptance and willingness to pay for renewable energy sources in Crete

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ARTICLE INFO

Article history:
Received 18 October 2009
Accepted 10 November 2009

Keywords:
Contingent valuation
Double bounded dichotomous choice
Renewable energy
Willingness to pay
Public acceptance
Public perceptions

ABSTRACT

The aim of this study is to analyse and to evaluate the citizens' public acceptance and willingness to pay (WTP), for Renewable Energy Sources (RES) in Crete. For this purpose a contingent valuation study was conducted, using a double bound dichotomous choice format to elicit people's WTP and factors affecting it. Residents of 1440 households all over Crete were interviewed face-to-face. Major conclusions can be used as a basis for sustainable energy planning, for policies and the formulation of awareness campaigns and for RES investment programs and projects in order to prepare implementation conditions and enhance public acceptance of renewable energy investments and programmes. Mean WTP per household was found to be 16.33€ to be paid quarterly as an additional charge on the electricity bill. Larger willingness to pay was reported by those with high family income and residence size, those having a higher level of energy information and awareness concerning climatic change, those who have invested in some energy saving measures, and those who suffer from more electricity shortages than others.

Contents

1. Introduction

In recent years climate change has been considered to be among the most serious threats to the earth's environment and to human health with potentially devastating worldwide economic costs [1]. The role of renewable energy sources (RES) in the mitigation of greenhouse gases, which is mainly responsible for climate change, is highly acknowledged [2]. Reducing the use of fossil fuels is currently one of the most important sustainability issues given the threat of global climate change [3,4].

The European Union (EU) Directive on production of electricity from renewable energy sources 2001/77/EC [5] sets an indicative target of 21% of electricity to be produced from renewable energy sources by 2010. In 2008 the EU proposed a binding target of 20% as the renewable energy source share of all Energy Consumption by

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doi:10.1016/j.rser.2009.11.009

2020 in the Directive 2009/28/EC [6] for Renewable Energy Sources. As national targets vary depending on past progress and feasible achievements by 2020, for Greece a binding target for RES is 18% accompanied by 4% reduction for greenhouses gases and 20% of energy saving in final energy use by 2020 [7]. On the other hand energy efficiency and renewable energy sources contribute greatly to the security of energy supply, to sustainable energy programming and planning and to the efficient energy management at local–regional–national level. The contribution of renewable energy sources to the energy sustainability is even higher for remote and insular areas, where their potential is usually high and the environmental constrictions are even stricter [8].

The households' share in the final Energy Consumption of the EU-27 is 25.89% which is equivalent to 304.9 Mtoe and in Greece the households' share is 25.58% which is equivalent to 5.5 Mtoe. The share of Renewable Energy Sources in 2006 on an EU-27 level in the final Energy Consumption was 9.2% and in Greece the corresponding percentage was 7.2%. The percentages for electricity from Renewable Energy Sources in gross electricity consumption in 2006 were for the EU-27 14.6% and for Greece 12.1%. The electricity prices for households (all taxes included) per 100 kWh in 2006 was for the EU-27 14.51€/100 kWh and in Greece 8.53€/100 kWh [9]. For the EU-27 in 2006 the CO_2 emissions were 4559 Mt, the energy per capita was 3695 kgoe/cap and the CO_2 per capita was 9230 kg/cap. In Greece, in 2006 the CO_2 emissions were 122 Mt, the energy per capita was 2826 kgoe/cap and the CO_2 per capita was 10,973 kg/cap [9].

Nowadays most of the citizens expect, more than in the past, their government or administration not only to warn them of major environmental–energy–climate problems, but also to prepare them for enacting timely policy responses. In the island of Crete, situated in the south–east Mediterranean the potential for energy production from wind, solar and agricultural biomass is very high due to the island's geography and prevailing climatic conditions. Despite the fact that the island of Crete is not connected by cable to the mainland of Greece, 13% of the electricity consumption is provided by the 154 MW of installed wind power of 1 MW pilot photovoltaic installations and of two small hydros of 0.6 MW. On the other hand 350,000 m^2 of solar thermal collectors and the biomass-to-energy valorization of the by-products of olive oil production provide more than 11% of the total energy demand of the island [10].

Recently sufficient motives have been offered to developing an adequate infrastructure (e.g. photovoltaics) as the promotion of renewable energy sources in Greece seems to become a serious component of the Greek energy policy [11,12]. Without any doubt the island of Crete is the Greek region and one of the European islands with the highest penetration of renewables. Its 8368 km^2, its permanent population of 601,263 inhabitants, the 3 million tourists annually and the existence of all kinds of productive activities, make the island of Crete an "ideal" ground for the inception and implementation of an alterative regional energy policy which strongly incorporates the wide implementation of nearly all forms of renewable energy sources, as well as, policies and projects of energy saving and rational energy use. It is also worth noticing that the defined geographic and physical borders of the island permit the quantitative monitoring and evaluation of the alternative energy policies and programs [13].

Batley et al. [14] recommend among other points, further research into the current environmental concerns of electricity customers, environmental consumer actions, level of awareness of renewable electricity as this would facilitate a greater understanding of the changes taking place in the production of electricity (deregulation). Ever since a number of such studies have been implemented worldwide but according to our knowledge there is not a study for Greece looking into the public acceptance and willingness to pay for all types of RES at a regional or national level.

For this reason we have decided to perform a contingent valuation (CV) study of the urban population of Crete looking into public attitudes over RES and their willingness to pay in order to achieve a more "green" electricity supply. This work was funded by a project implemented by the Regional Energy Agency of Crete (public administration) under the Interreg IIIC project [15]. The involvement of this public administration helps as government intervention is needed for promoting renewable energy [16].

The CV method is very often used to find out how people value goods and services for which no market exists [17,18]. Several studies have looked into residents' willingness to pay (WTP) for renewable energy. Nomura and Akai [19] have implemented a CV study by mail for finding household's WTP in Japan for renewable energy. Zarnikau [20] estimated the willingness to pay for investments in RES and energy efficiency resources in Texas, USA. Li et al. [21] run telephone and Internet based surveys for finding households' WTP for reducing USA reliance on fossil fuels. Soliño et al. [22] looked into the WTP for energy produced from biomass in Spain (2009). Also a number of recent studies look into WTP from households through a choice experiment methodology, another stated preference methodology for valuing environmental benefits [23–27]. The common point in the above reported studies of contingent valuation is that the installation of RES will improve the environmental sustainability, as in the framework of present paper. In our study, we focused only on the urban population because more than 80% of the electricity customers are included in this sample, and because there have been reported differences among rural and urban households in terms of welfare gains for RES [24] and this can result in different WTP [23].

2. Questionnaire design and research methodology

A questionnaire was designed to elicit residents' environmental/energy preferences and WTP for renewable energy sources project. In the questionnaire's introduction, the objective of the research and the involved parties were stated. The importance of truthful answers was clearly emphasized in order to reduce hypothetical market bias. Finally, it was stated that this research would help the Region of Crete-Regional Energy Agency of Crete and the other relevant authorities, to shape a regional energy policy including a tariff policy for RES.

The questionnaire consisted of five parts. The first part included some warm-up questions aiming to enlighten the respondent's environmental and energy profile. The second part of the questionnaire contained questions that concerned the energy characteristics of the respondents' residence and the reliability of the public electricity supply. The third part focuses on the perception and the practices of the respondent about energy saving.

At this point of the interview, there followed an information session about the RES. Figures were mentioned for installations that already operate on the island and the potential for their expansion. Also the advantages and the disadvantages of RES were explained. In addition photographs and charts with regard to the operating installations of all kids of RES and a "photovoltaic helicopter" whose propeller operated with the help of the sun, facilitating the respondent's comprehension of solar energy, were presented (see also Appendix 1).

The fourth part comprised the ranking of advantages and disadvantages of RES and the WTP question was shaped under three different initial sums of WTP – three scripts (in three different versions of the questionnaire). The question was: "If we suppose that the RES projects to be developed in Crete result into the environmental and social benefits already described to you,

and an additional cost is required, which would be included in your four-month bill of electricity, would you be willing to pay *x*€?" (where *x* was 5€ for the first, 10€ for the second and 12€ for the third version of the questionnaire, respectively). Those who had answered positively were asked about a higher bid, while those who had answered negatively, were asked a lower bid. This describes what is known as the double bound dichotomous choice (DB-DC) format question. We preferred this to the single dichotomous choice question because it is more efficient [28]. Finally, a follow up question was asked of those who had replied no to both willingness to pay questions. If the amount was zero, there was an additional question about the reasons behind his response. This would help us locate zero and protest bids. The last section of the questionnaire dealt with personal data and general socio-economic characteristics such as respondent's sex, age, family income, education level and others.

3. Data analysis

A total of 1440 interviews were conducted. The interviews were held in randomly from selected households of the six major cities of Crete (Heraklion, Chania, Rethymnon, Agios Nikolaos, Ierapetra and Sitia). This research took place from September 2006 to February 2007. Some important energy figures for households in Crete, information and awareness level for RES as well as the estimation of WTP for RES and factors affecting it are presented in this section.

3.1. Energy figures for households in Crete

Fig. 1 illustrates the heating modes of the Cretan households, where there can be observed a considerably high percentage (38.4%) using electric heating. Households may have more than one heating mode. Despite the fact that the air-conditioners used in heating mode are also included, an information and awareness campaign is needed to discourage, at least, the use of conventional electric heaters. New wood fire places are used in newly constructed apartments because of "fashion" reasons.

Households in Crete are billed twice quarterly. The first bimonthly bill is an estimation based on last year's figures while the second is based on the actual metering. Therefore all bills' figures in this paper will be reported quarterly. The mean value of the quarterly electricity bill of a Cretan household is 146.67€ for a household which roofs 2.74 members on average. The electricity cost per square meter varies between 0.57 and 15.99€/m^2, with a mean value of 1.56€/m^2 and the electricity cost per resident varies from 15 to 615€ with a mean value of 56.92€/resident. Table 1 provides some basic information statistics for households in Crete and some energy indices referred to the households in terms of having or not AC units.

If the house has an AC, the mean quarterly bill is 165.83€, while the average bill for houses without AC is 129.50€, giving a statistically significant difference of 36.33€ (t = 9.606, df = 1438, C.I. = 28.91–43.75€). The mean value for the quarterly bill/surface index is 1.52 and 16.2€/m^2 for houses without and with AC, respectively, giving a statistically significant difference of 0.955€/m^2 (t = 3.087, df = 1438, C.I. = 0.348–0.1561€/m^2). The mean value for the quarterly bill/resident index is 56.58 and 63.04€ for houses without and with AC, respectively, giving a statistically significant difference of 6.46€ (t = 3.513, df = 1438, C.I. = 2.85–10.07€).

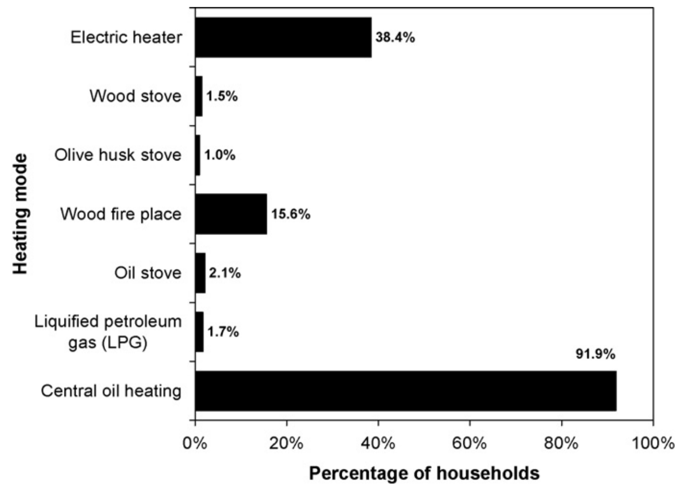

Fig. 1. Heating mode of households in Crete.

3.2. Information and awareness level for RES

To find out the level of information of respondents we asked all interviewed people if they knew that it is possible to produce energy from the wind, sun, hydraulic drop (water), biomass and biofuels. The responses are presented in the second column of Table 2. We also asked if they knew that there can be considerable energy saving from bioclimatic techniques of households, and only 39.2% knew about this possibility. We then asked which of these RES exist in Crete, and although all exist we received the responses of the third column of Table 2.

Looking into the figures of Table 2 it is evident that we have to target and intensify information-awareness activities towards energy production from biomass, biofuels and bioclimatic technologies, not only at a general level but also at the specific level of producing energy from the above renewable energy sources and technologies in Crete. According to the likert scale of our questionnaire, respondents find that the advantages and disadvantages of Renewable Energy Sources are as presented in Table 3.

Respondents find as very or very much important the following advantages: the reduction of the environmental damage of the

Table 1
Energy related figures for households in Crete with and without AC.

Statistics	Property area (m^2)		Quarterly bill (€)		Residents in household		Bill/surface (€/m^2)		Bill/Resident (€)	
	AC	No AC	AC	No AC	AC	No AC	AC	No AC	AC	No AC
Mean	105.29	85.82	165.83	129.50	3.01	2.58	1.62	1.52	63.04	56.58
Median	100.00	80.00	160.00	120.00	3.00	3.00	1.58	1.43	53.83	50.00
Standard deviation	40.59	35.95	71.25	67.67	1.19	1.15	0.55	0.57	34.97	30.88
Minimum	26.00	25.00	20.00	15.00	1.00	1.00	0.19	0.37	10.00	5.00
Maximum	320.00	340.00	600.00	500.00	8.00	8.00	5.00	5.33	205.00	200.00
25% percentile	80.00	65.00	120.00	80.00	2.00	2.00	1.26	1.18	37.50	35.00
75% percentile	120.00	100.00	200.00	160.00	4.00	3.00	1.88	1.79	80.00	70.25
N	522	918	522	918	522	918	522	918	522	918

Table 2
Stated knowledge of the respondents for all energy forms of RES ($N = 1440$).

RES	Generic knowledge ABOUT energy production	Knowledge ABOUT energy production in Crete percent
Wind energy	95.8	91.7
Solar energy	94.7	81.9
Hydro energy	74.3	43.0
Biomass energy	59.0	17.8
Biofuel energy	47.9	5.2

fossil fuels (75.1%), the increase of the security of energy supply of the island (71.2%), the reduction of the oil dependence and of oil contribution to national accounts balance (82.3%), the benefit for tourist development through a cleaner environment (78.5%), the increase of life quality because of the reduction of pollution (78.3%), the development of local expertise in RES (73.2%) and the creation of new jobs (78.8%). On the contrary, respondents find as very or very much important disadvantages: the visual pollution (36.67%), increased installation cost (71.8%) and fluctuations in their production availability (68.54%).

3.3. Estimation of willingness to pay for renewable energy sources

The frequencies of each of the four bid designs of the tree versions of our questionnaire are presented in Table 4. We used a follow up question for those who stated no to both the offered bids. This question asked for any offering amount and it was open to even one euro. This is done for locating and eliminating the "free-riders", who will eventually wish to consume the benefit from the RES development in Crete without paying extra, leaving this duty for others.

From the 1440 valid interviews 205 were identified as protest votes, using the filter question. Since this figure is a large portion of our sample (14.24%), these interviews were dropped from the analysis as those respondents did not reveal their willingness to pay. Zero bids were identified as 79 responses (i.e. 5.49% of the sample). The analysis that follows for the estimation of WTP was based on the remaining non-protest 1235 interviews. The reasons for households not being willing to pay are summarized in Table 5. Wiser [29] found a strong positive correlation between stated WTP and the expectations for the WTP of others. Therefore it is important to look into ways of revealing truth preferences and minimizing free riding.

The econometrics of DB-DC methodology are presented in Appendix 2. Mean and median WTP were estimated using the formulas suggested by Cameron [30] for WTP.

$$\text{Estimated WTP}_{\text{mean}} = \exp\left(\bar{x}\hat{\beta} + \frac{\hat{\sigma}^2}{2}\right) \quad (1)$$

$$\text{Estimated WTP}_{\text{median}} = \exp(\bar{x}\hat{\beta}) \quad (2)$$

where $\bar{x}$, vector of mean values of the explanatory variables; $\hat{\beta}$ vector of estimated coefficients; $\hat{\sigma}$, estimated σ.

Knowledge of WTP is necessary in order to carry out the economic analysis for RES projects. It can also be a useful tool in the hands of policy makers [25]. Mean and median WTP as an extra cost on their residence's quarterly electricity bill was estimated at

Table 3
Respondents' evaluation of advantages and disadvantages of RES.

	Very little important	Little important	Neutral	Very important	Very much important
Advantages					
Decrease of environmental impacts from the over exploitation and use of fossil fuels	1.39	7.15	16.39	43.61	31.46
Increase of the security of energy supply of the island	1.94	8.61	18.26	35.28	35.90
Reduction of the oil dependence and of oil contribution to national accounts balance	1.11	3.47	13.13	36.25	46.04
Benefit for tourism development through cleaner environment	1.04	5.35	15.14	39.44	39.03
Improvement of quality OF life due to pollution reduction	1.32	4.86	15.56	39.03	39.24
Development of local know how on RES technologies, AS in the case of Solar heaters	1.81	5.63	19.38	35.69	37.50
Creation of new jobs	1.11	5.76	14.31	36.88	41.94
Disadvantages					
Visual pollution, especially for wind energy	16.46	25.76	21.11	23.61	13.06
Increased installation cost	2.22	7.22	18.75	37.08	34.72
Fluctuations in their production availability	2.50	9.38	19.58	32.50	36.04

Table 4
Surveyed households frequency classified by bid values (percentages in parenthesis).

Questionnaire version	Bid values [initial:upper:lower]	YY	YN	NY	NN	Total
1	[5:10:3]	214 (44.4)	141 (29.3)	32 (6.6)	95 (19.7)	482
2	[10:15:5]	181 (37.9)	128 (26.8)	75 (15.7)	93 (19.5)	477
3	[12:20:8]	122 (25.4)	126 (26.2)	72 (15)	161 (33.5)	481
Total		517	395	173	349	1440

Table 5
Reasons for not being willing to pay ($n = 1440$).

Reason	Classification	Frequency	Percent
I believe these installations should already have been built with the money I pay	Protest	147	10.2
I'm tired of paying for many other services related to the Public Power Corporation	Protest	54	3.8
I don't believe the quality of the environment will improve even if RES are developed	Zero	49	3.4
I don't have money	Zero	24	1.7
It isn't worth paying extra because I don't have a positive view of RES	Zero	6	0.4
Other	Protest	4	0.3

Table 6
Mean, median WTP and 95% confidence intervals in €.

Statistic	WTP	95% confidence interval
Mean	16.33	15.29–17.37
Median	12.95	12.18–13.72

16.33€ and 12.95€, respectively (Table 6). The delta method was used to obtain the confidence intervals [31].

The mean WTP figure of Table 6 corresponds to 17.88€ per person per year. Positive willingness to pay for RES has been reported by all stated preference applications to the best of our knowledge.

3.4. Factors explaining willingness to pay for renewable energy sources

Variables were recoded and/or were dummy coded for the analysis. These were used as explanatory variables in the estimated model as described in Table 7. Mean values and standard deviation are also reported.

With the likelihood ratio test we kept dropping insignificant variables until we reached the version presented in Table 8. Asterisks declare the level of significance. Variables with a t-statistic greater than 1.3 were kept in the model and are discussed as follows. We also discuss variables with limited statistical significance presented in Table 8 and state the p-value for all variables in the model.

Respondents worried more about the energy status of Crete (ENCR) and those considering that the climate change (PRO12) is an important problem for Crete want to pay on average more for the development of RES ($\beta = 0.0855,\ p = 0.0759$) and ($\beta = 0.1902,\ p = 0.001$), respectively, compared to those less worried about the energy status in Crete and those not considering climatic change to be an important problem. The above findings confirm that people with high energy awareness are positive concerning the further implementation of RES. This also proves that climate change mitigation is firmly linked with more use and WTP for RES [25,32] and that local energy and environmental problems are directly linked with global ones. These results also point out that regional and local campaigns about serious global concerns like climate change may raise public awareness and WTP.

Table 8
Estimation results.

Variable	Coefficient	t-Statistic
C	0.9456	6.0952
ADV1	0.1158	2.1017*
ADV5	0.0817	1.3613
ADV7	0.1401	2.4574*
DIS3	0.0746	1.5584
ESUN	0.3214	3.3763***
EBFU	0.1236	2.5668*
ENCR	0.0855	1.7751
INC1	0.2725	3.2317**
INC2	0.3404	3.4158***
INC3	0.9072	4.3682***
INTER1	0.2051	2.2271*
INTER2	0.1916	2.0045*
INTER3	0.2865	2.5050*
PRO12	0.1902	3.9610***
SAVE1	0.1715	3.3269***
SAVE2	−0.2376	−3.8103***
SAVE6	0.1060	1.9809*
SAVE7	0.0685	1.3796
SQM	0.0017	2.5456*
σ	0.6815	31.4253
Log likelihood	−1442.18	

* Significant at the 5% level.
** Significant at the 1% level.
*** Significant at the 1‰ level.

People knowing that it is possible to produce energy from the sun (ESUN) are willing to pay on average more for RES ($\beta = 0.3214,\ p = 0.0007$) than those who do not. This finding can be explained by the fact that for the public opinion in Crete the generic term "solar energy" comprises all forms of RES and because "solar energy" for Crete is firmly identified with the widespread use of hot water solar heaters [33]. Local awareness campaigns have also to consider that the term "solar energy" means, for the public, mostly all forms of RES and that the extensive local experience concerning hot water solar heaters is an advantage for further exploitation.

Furthermore people knowing that it is possible to produce energy from liquid biofuels (EBFU) are willing to pay on average more ($\beta = 0.1236,\ p = 0.0103$) for RES than those who do not. This is because this specific knowledge already presupposes a high

Table 7
List of variables and descriptive statistics.

Variable	Description	Mean	Standard deviation
ADV1	Value the advantage of RES "Decrease of environmental impacts from the over exploitation and use of fossil fuels" as: 1: Important, 0: Not important	0.7457	0.4356
ADV5	Value the advantage of RES "Improvement of quality of life due to pollution reduction" as: 1: Important, 0: Not important	0.7733	0.4189
ADV7	Value the advantage of RES "Creation of new jobs" as: 1: Important, 0: Not important	0.7854	0.4107
DIS3	Value the disadvantage of RES "Fluctuations in their availability" as: 1: Important, 0: Not important	0.7012	0.4579
ESUN	Do you know that energy can be produced by the sun: 1: Yes, 0: No	0.9482	0.2218
EBFU	Do you know that energy can be produced by biofuels: 1: Yes, 0: No	0.3968	0.4894
ENCR	How much you are worried about the energy status in Crete: 1: Much and very much, 0: Little and not at all	0.6494	0.4774
INC1[a]	Annual family income: 1: 7001–28,000€, 0: Otherwise	0.7028	0.4572
INC2	Annual family income: 1: 28,001–56,000€, 0: Otherwise	0.2130	0.4096
INC3	Annual family income: 1: >56,000€, 0: Otherwise	0.0170	0.1293
INTER1[b]	Biannual electricity cuts: 2–5 times	0.5215	0.4997
INTER2	Biannual electricity cuts: 6–10 times	0.3231	0.4678
INTER3	Biannual electricity cuts: >10 times	0.0874	0.2826
PRO12	Evaluate the problem of climatic change: 1: Important, 0: Not important	0.6713	0.4699
SAVE1	Have installed solar water heater: 1: Yes, 0: No	0.6381	0.4808
SAVE2	Have agreed a nocturnal tariff: 1: Yes, 0: No	0.1368	0.3438
SAVE6	Rational air conditioning (off-peak) use: 1: Yes, 0: No	0.2858	0.4520
SAVE7	Have installed double glazing: 1: Yes, 0: No	0.3862	0.4871
SQM	Surface area of the house in m^3	93.7287	38.7292

[a] The hidden variable is ≤7000.
[b] The hidden variable is those who responded none and once.

awareness level for energy and RES issues. High information level also results in higher WTP in investments for RES [20].

Because of the fact that Crete is not connected by cable to the mainland of Greece and because of the high development of the seasonal tourism during the summer period it is likely for some households to have experienced a few minutes of electricity shortages (INTER1, INTER2, INTER3). The more frequent the electricity shortages, the more the respondent is wiling to pay ($\widehat{\beta} = 0.2051$, $p = 0.0259$; $\widehat{\beta} = 0.1916$, $p = 0.0450$; $\widehat{\beta} = 0.2865$, $p = 0122$, respectively for 2–5, 6–10 and more than 10 biannual electricity cuts, respectively). Similar findings are reported by Longo et al. [25]. This is an expected finding since it verifies the fact that citizens would be willing to pay anyhow for reducing the electricity cuts due to the negative welfare effects on the households [34]. Therefore RES considered contributing to the enhanced security of energy supply which is also practically proven by the continuous operation of the installed wind parks in Crete during the summer peak hours of high electricity power demand.

Respondents with high level of energy saving practices and behavior, namely: installation and use of hot water solar heater (SAVE1), energy efficient use of air conditioning (SAVE6) and installation of double glazing (SAVE7), are willing to pay on average more ($\widehat{\beta} = 0.1715$, $p = 0.009$; $\widehat{\beta} = 0.1060$, $p = 0.0476$; $\widehat{\beta} = 0.0685$, $p = 0.1677$) for RES than those who do not have these energy saving practices. It is proven that high awareness levels or energy responsible behavior for energy saving are firmly linked to the positive perception and attitudes for RES and these links have to be exploited and developed during the formulation and implementation of information/awareness campaigns and for the realization of RES investments.

Contrary to the above finding, respondents using reduced a electricity night tariff for electricity heat accumulators (SAVE2), are less willing to pay for RES ($\widehat{\beta} = -0.2376$, $p = 0.001$). This could be explained by the fact that they are mostly "money oriented savers" and not "energy oriented savers".

Respondents who highly rank the advantage of RES for the reduction of environmental impacts because of the extraction and use of fossil fuels (ADV1) is lessened, and because of the advantage of RES for enhanced quality of life and pollution reduction (ADV5) is improved, as well as, because of the advantage concerning the creation new jobs (ADV7), are those willing to pay on average more for RES ($\widehat{\beta} = 0.1158$, $p = 0.0356$; $\widehat{\beta} = 0.0817$, $p = 0.1743$; $\widehat{\beta} = 0.1401$, $p = 0.0140$, respectively) than those not ranking those advantages as important.

These results prove that the environmental image and benefits of RES and the generic reasoning based on their environmental advantages have to be explained and developed during the formulation of information and of investment programs and strategies. In the same way something very positive is the direct link of RES with the creation of new jobs, an always dominant worldwide problem. Longo et al. [25] found that supporters of RES value in favor of the creation of new jobs. Also, Bergmann et al. [23] reported higher WTP for RES projects by rural populations in Scotland due to the creation of new jobs.

Considering the disadvantages of RES, the respondents considering as a serious disadvantage the fluctuation in their availability (DIS3) are willing to pay on average more ($\widehat{\beta} = 0.0746$, $p = 0.1191$) than those who believe it not to be an important disadvantage. This consideration presupposes high awareness level for RES and willingness to overcome this disadvantage, by new installations and RES technologies. It is worth mentioning that disadvantages do not negatively affect willingness to pay, since there are cases that there was opposition to RES projects [35].

Respondents with high family incomes (INC1, INC2, INC3) are willing to pay on average more than those of low incomes ($\widehat{\beta} = 0.2725$, $p = 0.0012$; $\widehat{\beta} = 0.3404$, $p = 0.0006$; $\widehat{\beta} = 0.9072$, $p < 0.0001$). This is an expected finding in CV studies and is also reported by energy related studies [20,29,36,25,21].

Respondents staying in large houses (SQM) are willing to pay on average more for RES ($\widehat{\beta} = 0.0017$, $p = 0.109$) than those who live in small houses. This is an expected finding as living in a large house implies a high welfare level.

4. Conclusions and policy recommendations

This paper investigates the factors concerning social acceptability and the necessary conditions for the wide implementation of Renewable Energy sources in the island of Crete, using also the CV methodology to estimate the WTP of the target population. This valuation research reveals that the vast majority of households of Crete is very positively disposed towards the implementation of Renewable Energy Sources in Crete and places high value on the advantages of RES. Mean willingness to pay is calculated at 17.88€ per person per year.

The analysis of results provides valuable insight into the determinants of public attitudes towards the implementation of Renewable Energy Sources at regional, national and European levels. Relevant policy makers should take into consideration the above-mentioned findings in order to plan appropriate projects, to select implementation methodologies and to formulate action and implementation plans – of short, medium and long perspective – for Renewable Energy Sources.

It is obvious that there is a great need for raising awareness of all categories of citizens by continuous and focused campaigns concerning the Renewable Energy Sources, linked not only to the general issues, e.g. climate change but also to the local specific circumstances, e.g. tourist development or security of energy supply of insular regions. There are import information gaps and misleading perceptions – concerning Renewable Energy Sources – of the general public, of specific population groups and of decision makers at various levels. Nowadays having determined binding targets for Renewable Energy Sources, greenhouses mitigation and energy saving at macro levels, the implementation of the required Energy and Climate Road maps at European and national, regional and local levels [37] are going through constant and specific well-designed and documented information campaigns and valuation exercises.

It is of high interest to policy makers and to Public Administrations that they know how much more individuals and citizens are willing to pay for Renewable Energy than for fossil fuel energy and which factors are positively affecting this willingness.

All European countries dispose supportive policies and favorable investment frameworks for Renewable Energy Sources in order to achieve the market penetration required for fulfilling the binding energy and climate targets.

The efficient implementation of the projects and installations of Renewable Energy Sources in time have to take seriously into consideration the relative public perception, awareness attitude, behavior and acceptability. This is also a perfect occasion to link firmly the use of Renewable Energy Sources with the prerequisite of energy saving and energy efficiency. Raising energy awareness and providing adequate information contribute to converting the passive consumer into a responsible and active citizen who will participate in the shaping of the energy and environmental present and future.

Acknowledgements

This work was cofinanced by Interreg IIIC "Action program for Sustainable Strengthening Energy Efficiency and Source Saving by Sustainable Local Development in European Regions (ENERCY

Fig. 2. Demonstration device for RES.

REGIO)/Subproject: Practical Training in Companies", where Regional Energy Agency of Crete was a partner.

Appendix A. Briefing of the information material

The information material consisted of 3 parts

1. The first part was a double sided leaflet consisting of printed information about the suitability of RES focusing ON the island of Crete. A brief introduction and the general benefits of RES, the state of the art in figures and the potential to expand their application in Crete were presented. The specific information provided was:
   - There are 15 wind farms in Crete producing electricity to cover the needs of 66,000 population equivalent (p.e.), but this could be tripled.
   - Photovoltaic parks in Crete produce electricity to cover the needs of 1100 population equivalent (p.e.), but this could be 50 times higher.
   - Small hydroelectric plants in Crete produce electricity to cover the needs of 450 population equivalent (p.e.), but this could be 10 times higher.
   - Solar heaters save electrical energy as the needs of 75,000 population equivalent (p.e.), but this could be 4 times higher.
   - A bioclimatic home in Crete can save 80% of the annual heating and cooling cost, compared to a conventional one.
   - A greenhouse, a house or a block of houses that use olive husk as a heating source, results in 65% saving over the cost of heating.

   Then an extensive list of advantages and disadvantages from the RES were presented and discussed. All these advantages and disadvantages were "neutrally" presented in order not to guide the respondents in favor of or against anyone of them.
2. This was a printed double sided leaflet consisting of colored photos and schematic presentation of all kinds of RES. This was handled to the interviewed person in order to visualize the different types of relevant information.
3. Furthermore a demonstration "helicopter" was used in order to show how is possible to receive energy from the sun. The "helicopter" had a mini photovoltaic cell on top as shown in Fig. 2.

Appendix B. The econometrics of DB-DC methodology

The model we attempted to estimate is of the form $\ln(\mathrm{WTP}_i) = Y_i^* = X_i\beta + \varepsilon_i$ where i is the consumer index and $\varepsilon_i \sim N(0, \sigma^2)$. This relationship does not fall under the usual simple regression framework, because Y_i^* is not observed, namely we do not observe the respondent's real WTP. What we observe is whether consumers say YES or NO to a certain bid. Consumers have the following four answer response options to the two consecutive bids offered to them:

$$\begin{aligned} &\text{Response for bid } 1: Y_{1i} = 1 \text{ if } \ln(\mathrm{WTP}_i) = Y_i^* > t_{1i} \\ &\qquad Y_{1i} = 0 \text{ if } \ln(\mathrm{WTP}_i) = Y_i^* \le t_{1i} \\ &\text{Response for bid } 2: Y_{2i} = 1 \text{ if } \ln(\mathrm{WTP}_i) = Y_i^* > t_{2i} \\ &\qquad Y_{2i} = 0 \text{ if } \ln(\mathrm{WTP}_i) = Y_i^* \le t_{2i} \end{aligned} \tag{A1}$$

t_{1i} and t_{2i} stand for the natural log of the two bids. Or equivalently, the probabilities corresponding to the four options are:

1st option

$$\begin{aligned} P[Y_{i1} = 1, Y_{i2} = 1] &= P[Y_i^* > t_{i1}, Y_i^* > t_{i2}] \\ &= P\left[\frac{\varepsilon_i}{\sigma} > \frac{t_{i1} - x_i'\beta}{\sigma}, \frac{\varepsilon_i}{\sigma} > \frac{t_{i2} - x_i'\beta}{\sigma}\right] = P\left[\frac{\varepsilon_i}{\sigma} > \frac{t_{i2} - x_i'\beta}{\sigma}\right] \end{aligned} \tag{A2}$$

2nd option

$$\begin{aligned} P[Y_{i1} = 1, Y_{i2} = 0] &= P[Y_i^* > t_{i1}, Y_i^* \le t_{i2}] \\ &= P\left[\frac{t_{i1} - x_i'\beta}{\sigma} < \frac{\varepsilon_i}{\sigma} \le \frac{t_{i2} - x_i'\beta}{\sigma}\right] \end{aligned} \tag{A3}$$

3rd option

$$\begin{aligned} P[Y_{i1} = 0, Y_{i2} = 1] &= P[Y_i^* \le t_{i1}, Y_i^* > t_{i2}] \\ &= P\left[\frac{t_{i2} - x_i'\beta}{\sigma} < \frac{\varepsilon_i}{\sigma} \le \frac{t_{i1} - x_i'\beta}{\sigma}\right] \end{aligned} \tag{A4}$$

4th option

$$P[Y_{i1} = 0, Y_{i2} = 0] = P\left[\frac{\varepsilon_i}{\sigma} \le \frac{t_{i2} - x_i'\beta}{\sigma}\right] \tag{A5}$$

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